fitness for aviation and other vocations for which speed and accuracy of adjustment of the eye for clear seeing at different distances are a prerequisite.

In accordance with plans for cooperation of the Bureau of Chemistry and the Bureau of Fisheries on problems of preparation and preservation of fishery products for food, Dr. F. C. Weber, of the Bureau of Chemistry, and Drs. G. G. Scott and W. W. Browne, of the College of the City of New York, temporary assistants of the Bureau of Fisheries, have begun work for the summer at Perkins Laboratory, Gloucester, Mass., where facilities and cooperation are afforded by the Gorton-Pew Fisheries Co.

UNIVERSITY AND EDUCATIONAL NEWS

The University of Chicago has received from Mr. La Verne Noyes a gift of $2,500,000, to be used in the education of soldiers and sailors and their descendents after the war. In addition the fund provides for the perpetuation of instruction in American history and the public duties of citizenship.

Columbia University is a beneficiary under the will of Major Eugene Wilson Caldwell, of the United States Medical Reserve Corps, from two trust funds upon the death of life tenants to support a foundation for general educational work. Dr. Caldwell died in Roosevelt Hospital from burns received while experimenting with X-rays. His estate was valued at more than $150,000.

The Kansas City Veterinary College, after an existence of twenty-seven years, during which it has graduated nearly 1,700 men, has decided to abandon the field of veterinary education. It has transferred to the Kansas State Agricultural College its records and good will, and made arrangements with that institution to take over its students as far as possible and agreeable to them.

The Department of Chemistry of the State College of Washington, Pullman, Washington, announces the establishment of a fellowship, to be devoted to research on the extension of the chemical uses of magnesite, paying $600 a year.

Dr. C. W. McCampbell, for eight years a member of the department of animal husbandry of the Kansas State Agricultural College, is the new head of the department, succeeding Professor W. A. Cochel, who has resigned.

Professor J. H. Ransom, after eighteen years in Purdue University, has accepted the professorship of chemistry and director of the chemical laboratories in Vanderbilt University, Nashville, Tenn.

W. V. Lovitt, Ph.D., Chicago, of the mathematical department of Purdue University, has been appointed associate professor of mathematics in Colorado College.

The electors to the Harkness scholarship in geology in Cambridge University have recommended that the scholarship for women for 1918 be awarded to Majorie E. J. Chandler, Newnham College.

Sir Charles Parsons has accepted the office of president of the Polytechnic School of Engineering, London, in succession to the late Mr. Charles Hawksley.

Dr. Maud Kinnaman, of Washington, N. J., has been made head of the new medical college at Vellore, India.

DISCUSSION AND CORRESPONDENCE

THE FUNDAMENTALS OF DYNAMICS

Most discussions of elementary mechanics refer to variations in point of view and especially to variations of emphasis which are all equally logical and all fully understood by careful students of the subject. Therefore, discussions of elementary mechanics usually say a great deal to "put over" a mere grain of edification, and Professor E. V. Huntington's recent discussions of elementary mechanics in Science and in the *American Mathematical Monthly* is no exception to the general rule. From the most favorable point of view, Professor Huntington's discussion is much ado about nothing; but from our point of view it

is much worse than that. If we were not convinced that Professor Huntington is definitely mistaken in several important matters we would not, for a third time, take part in the discussion.

1. Professor Huntington urges the use of the term *standard weight,* the *weight* of a body in London in "pounds,"[1] instead of *mass.* Now what we call the mass of a body is independent of time and place, it is an invariant[2] relation between the given body and the standard kilogram (a piece of metal), and extraneous and confusing ideas would be involved in the term *standard weight,* because this term implies location and a relationship between the given body and the earth. How awkward it would be, for example, to be obliged always to speak of the distance d between two points (x, y, z) and (x', y', z') as $[(x-x')^2+(y-y')^2+(z-z')^2]_{\frac{1}{2}}$. This function is an invariant, and the most useful name or symbol for it is a name or symbol which carries no redundant suggestions as to particular axes of reference, *and this would be true even if we had always to make use of particular axes of reference in the measurement of d.* The word *mass* is widely used by physicists and chemists for an idea which is independent of time and place and which does not involve any relationship with the earth (this is true even though mass be determined by weighing), and it is simply out of the question to use for this idea the term *standard weight* with its redundant and misleading suggestions.

2. To be unfriendly to the term *mass* and to prefer the term *standard weight* is of course a small matter; but Professor Huntington seems to go much deeper than mere terminology. He insists, for example, on the equation $F/F' = a/a'$ as THE fundamental equation of dynamics, although several correspondents in SCIENCE have called his attention to the fact that acceleration not only varies from force to force for a given body *but also from body to body for a given force.* Both of these fundamental modes of variation must be formulated as fundamental equations of dynamics. Professor Huntington states[3] that the variation-from-body-to-body-for-a-given-force is logically derivable from the variation-from-force-to-force-for-a-given-body, and the object of the following discussion is to make it clearly evident that Professor Huntington's statement is not true.

Given three bodies A, B, and C, and three identifiable forces a, b and c. Let the acceleration of each body due to each force be *observed,* the results being shown in the accompanying table. Let us suppose that the table has been

TABLE OF OBSERVED ACCELERATIONS

		Bodies		
		A	B	C
Forces	a	25	30	35
	b	50	60	70
	c	75	90	105

extended so as to include a great many different forces and a great many different bodies, then a careful inspection of the table would lead to the following generalizations:

(a) If one force produces twice as much acceleration as another force when acting on a given body, then the one force produces twice as much acceleration as the other force when acting on *any body whatever.*

(b) If one body is accelerated twice as much as another body under the action of a given force, then the one body is accelerated twice as much as the other body under the action of *any force whatever.*

The experimental fact (a) makes it convenient to define the ratio of two forces as the ratio of the accelerations they produce when acting on a given body, because this ratio is the same for all bodies.

That is

$$\frac{F}{F'}=\frac{a}{a'}, \tag{1}$$

[1] The "pound" here means the pull of the earth on a one-pound body in London.

[2] No consideration is here given to variations of mass as recognized in the recent developments of the principle of relativity.

[3] SCIENCE, March 3, 1916, page 315.

where a is the acceleration of a given body produced by force F, and a' is the acceleration produced by force F'.

The experimental fact (*b*) makes it convenient to define the ratio of the masses of two bodies as the inverse ratio of the accelerations produced by a given force, because this ratio is the same for all forces.
That is

$$\frac{m}{m'} = \frac{a'}{a}, \tag{2}$$

where a is the acceleration of body No. 1 and a' is the acceleration of body No. 2, both produced by a given force, and m and m' are the masses of the respective bodies.

We prefer to define mass quantitatively in terms of the operation of weighing by a balance scale and to look upon equation (2) as an experimental discovery; but in any case equations (1) and (2) are independent and they are the fundamental equations of dynamics.

Equation (1) applies to a given body, and pure logic would not even know of the existence of another body, so that equation (2), inasmuch as it refers to at least two bodies, can not be a logical consequence of equation (1). It is surprising to us to have Professor Huntington refer[4] to the above table of observed accelerations in support of his statement that equation (2) is a logical or mathematical consequence of equation (1). Of course we have not observed these accelerations, but in the last analysis they are dependent on observation and upon nothing else.

3. Professor Huntington's statements as to systematic units are very much like most current text-book statements touching this matter. "Fundamental units may be chosen at pleasure"—so all of our talking physicists say, mentioning only the evident condition that material standards thereof must be carefully preserved. Working physicists, however, know that the fundamental quantities must be susceptible of very accurate measurement under all sorts of conditions and in all kinds of relations *because the definition of a derived unit can not be realized with greater accuracy than the fundamental quantities can be measured.* Think of the years of confusion in electrical measurements when the theoretical ohm could not be produced with greater accuracy than, say, one per cent., but when almost anybody could make resistance measurements to, say, a hundredth of one per cent! When we recall that old nightmare we are inclined to smile at the childish pleasure with which many teachers talk about choosing fundamental units. Indeed, one fundamental unit would be enough if certain measurements, which would then be fundamental, could be made with sufficient accuracy. This important condition of *accurate realization of derived units* makes it undesirable to use the pull of the earth on a one-pound body in London (or on a one-gram body) as a fundamental unit in any universally practicable system. As a matter of widest practise the use of the unit of force as a fundamental unit is out of the question. We admit, however, and here we differ from some of our colleagues in physics, that the C.G.S. system (or the F.P.S. system) is less convenient than the foot-slug-second system in some fields of engineering.[5]

4. It is extremely amusing to read Professor Huntington's naïve suggestion that a unit of force might be preserved in the form of a standard spring. This is laughable for two reasons, namely, (*a*) because the pull of the earth on a one-pound body in London is perhaps as invariable as its mass so that no standard spring is needed to preserve a unit of force, and (*b*) because, as every working physicist knows, the most carefully "aged" springs grow very perceptibly softer in time. Tempered steel and phosphor bronze and fused quartz are unstable substances.

5. We are at a loss to understand the significance of Professor Huntington's efforts to establish order in the fundamental view points of mechanics except on the assumption that he has felt, somewhat vaguely, the central fallacy,

[4] SCIENCE, March 3, 1916, page 315.

[5] We publish in a current number of the *Bulletin* of the Society for the Promotion of Engineering Education a brief and simple discussion of this subject, a discussion which we think may show the way to a general agreement among writers on mechanics.

namely, (*a*) the willing agreement among all technical writers to use the word *weight* to designate the earth pull on a body, followed by (*b*) a careless reversion to the usage of the coal man and the acceptance of his meaning when he sends a bill for 2,000 pounds weight of coal! Let it be understood that the coal man's weight is precisely the physicist's and the chemist's mass. The balance scale measures mass, it does not and can not measure force in any precise sense until the ratio of the local value of gravity to the value of gravity in London is known.

Wm. S. Franklin,
Barry MacNutt

THE CANONS OF COMPARATIVE ANATOMY

In a recent number of Science[1] Professor W. P. Thompson refers to a recent letter of mine to that journal. He maintains that the assertion on my part that he made use of the Canons of Comparative Anatomy through ignorance to reach an erroneous conclusion is inaccurate. This seems to be contrary to the facts, since Professor Thompson on his own showing is culpable either of inexcusable ignorance or deliberate misrepresentation. He emphasizes the value of the genus *Vaccinium* as a type illustrative of the relations between two main forms of vessel in the angiosperms, namely, the one with scalariform perforations and that with porous perforations. Had his acquaintance with the anatomy of *Vaccinium* been more complete, he would have realized that the type of vessel found in the Gnetalian genus *Ephedra* is also present there. Contrary to Mr. Thompson's statement, moreover, vessels of the *Gnetum* type prevail in the higher angiosperms rather than in the lower ones, being universal, for example, in the Compositæ and extremely common in the monocotyledons. It is unfortunate that Professor Thompson either through ignorance or intention has failed to emphasize the presence of the *Gnetum* type of vessel in the angiosperms, particularly as in many cases it has in that large group a mode of origin similar to that described by him in the case of *Gnetum*. It thus appears that his contention that the *Gnetum* and *Ephedra* types of vessels are fundamentally different in origin from those of the angiosperms is without foundation in fact, since both these types are actually present in quite high angiosperms. Professor Thompson's attitude is further highly inconsistent, since in earlier publication he has called attention to the resemblances between the wood rays of *Ephedra* and those of certain angiosperms, and to the occurrence of nuclear fusions in *Gnetum* which he compares with that found in the case of the endosperm nucleus of the angiosperms.

E. C. Jeffrey

1 N. S., Vol. XLVII., No. 1221.

WHOLE-WHEAT BREAD

To the Editor of Science: As a contribution to the discussion "Shall We Eat Whole-wheat Bread,"[1] may I quote from the findings of a special committee appointed by the Royal Society of England, to study this matter,[2] as follows:

The bread now in use is prepared from grain milled to 90 per cent. with the addition of other cereals. After investigation, a committee of the Royal Society has issued a report on the following questions: (1) What gain, if any, in food value accrues from a rise in the milling standard from 80 to 90 per cent., and does the dilution of wheat flour with other cereals modify the food value of the bread? (2) What would be the effect on the health of the consumption of such breads? (3) How far would such breads prove acceptable? Experiments were made with wheat flour, extracted to 80 and to 90 per cent. The analytical work was done in the biochemical department of the University of Cambridge and in the physiological laboratories of the universities of Glasgow and London. The diet consisted of 800 gm. of bread with butter, cheese, minced or potted meat, fruit jelly, milk and sugar, tea or coffee, and in one case beer was taken as a beverage. This dietary yielded about 3,680 calories a day. *The effects were remarkably uniform.*[3] Bread made from the 80 per cent. flour yielded for nutrition 96.1 per cent. of the energy contained in the diet; bread made from 90 per

1 "The Conservation of Wheat," Science, Vol. XLVII., No. 1218, p. 429; Science, N. S., Vol. XLVII., No. 1210, p. 228, March 8, 1918.

2 Copied from the *J. Amer. Med. Assn.*, Vol. 70, No. 22, p. 1619, June 1, 1918.

3 The italics are my own.